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Cooling System Overview: Summit Supercomputer

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U.S. DEPARTMENT OF ENERGY

Today's Presentation

- System Description
- Cooling System Components
- Cooling System Performance

NOVEMBER 2018 #1

Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
2,397,824	143,500.0	200,794.9	9,783

JUNE 2018 #1

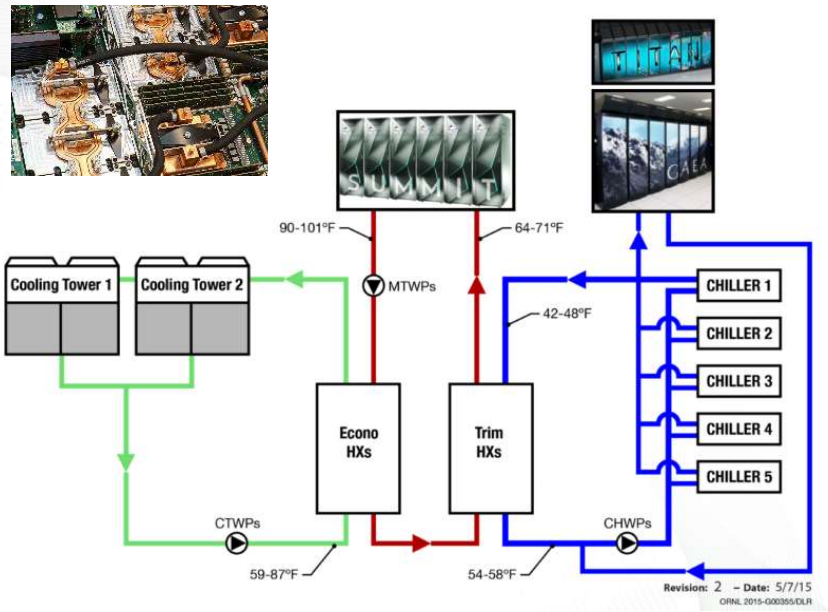
Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
2,282,544	122,300.0	187,659.3	8,806

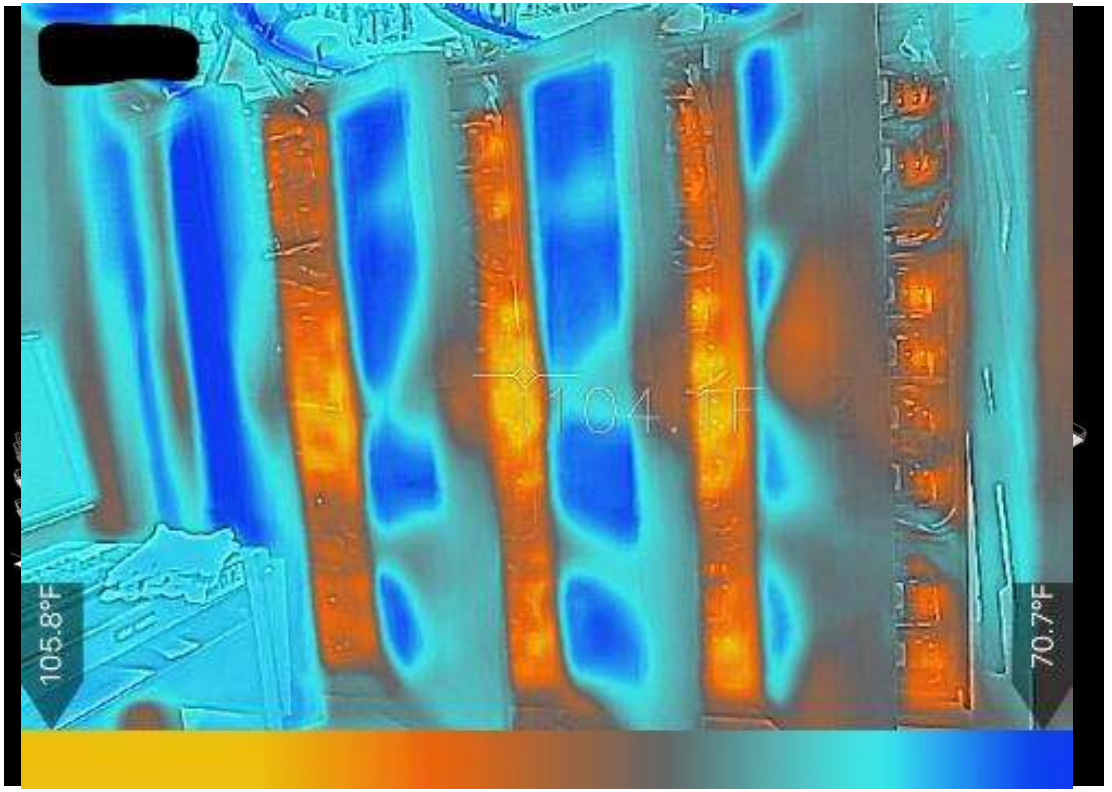
Summit Node Overview

Feature	Titan	Summit
Application Performance	Baseline	5-10x Titan
Number of Nodes	18,688	4,608
Node performance	1.4 TF	42 TF
Memory per Node	32 GB DDR3 + 6 GB GDDR5	512 GB DDR4 + 96 GB HBM2
NV memory per Node	0	1600 GB
Total System Memory	710 TB	>10 PB DDR4 + HBM2 + Non-volatile
System Interconnect	Gemini (6.4 GB/s)	Dual Rail EDR-IB (25 GB/s)
Interconnect Topology	3D Torus	Non-blocking Fat Tree
Bi-Section Bandwidth	15.6 TB/s	115.2 TB/s
Processors	1 AMD Opteron™ 1 NVIDIA Kepler™	2 IBM POWER9™ 6 NVIDIA Volta™
File System	32 PB, 1 TB/s, Lustre®	250 PB, 2.5 TB/s, GPFS™
Peak Power Consumption	9 MW	13 MW

System Description – How do we cool it?

- >100,000 liquid connections





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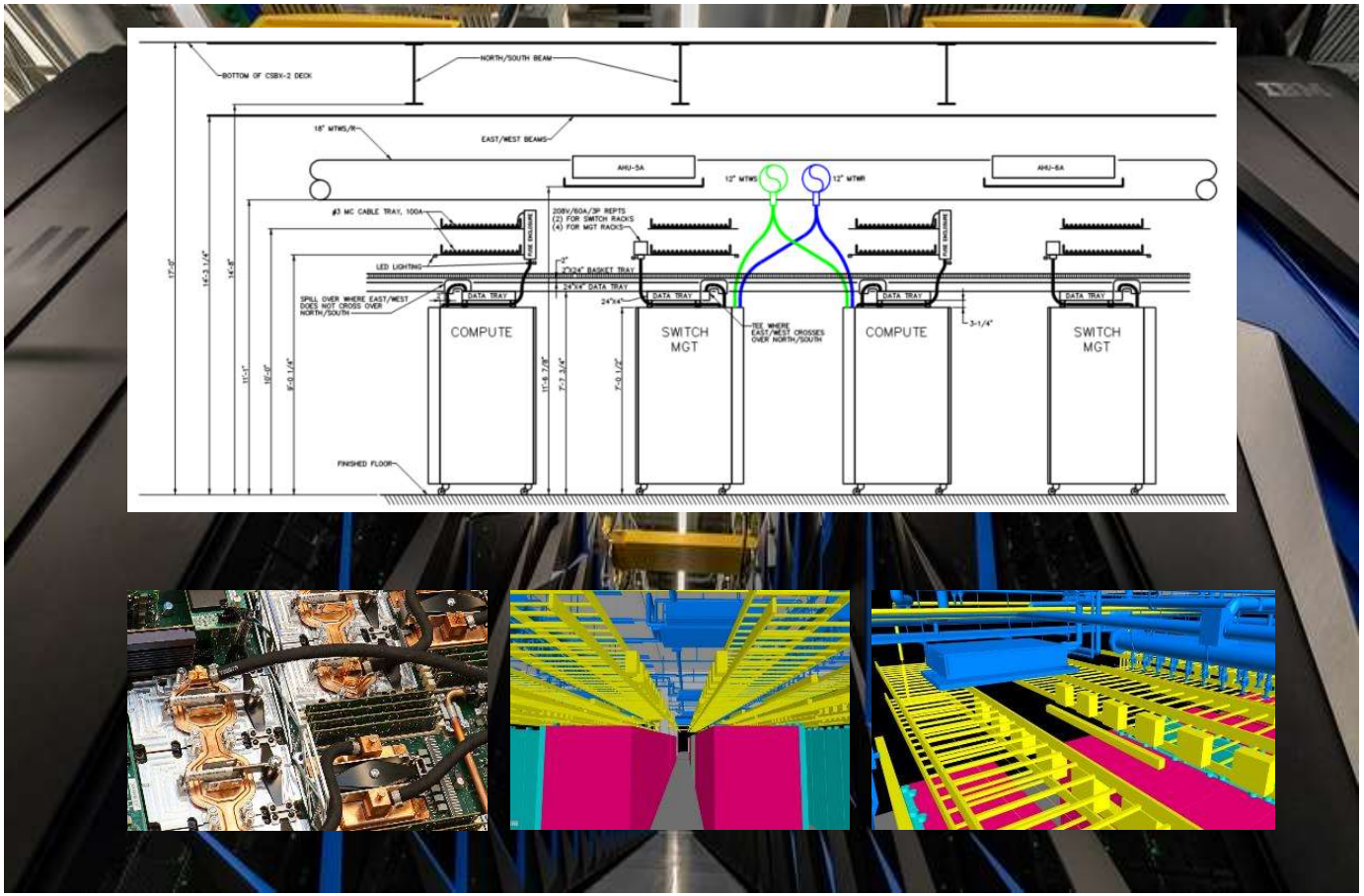
System Description – What's in the data center?

- **Passive RDHXs**- 215,150ft^2 (19,988m^2) of total heat exchange surface (>20X the area of the data center)
  - With a 70°F (21.1 °C) entering water temperature, the room averages ~73°F (22.8°C) with ~3.5MW load and ~75.5°F (23.9°C) with ~10MW load. Note that only ~25% of compute rack load is on the RDHXs.
  - The racks turn over the data center's air volume 2-3 times each minute when under load.
- **CPU cold plates** – 4,105ft^2 (381m^2) of total heat exchange surface
- **GPU cold plates** – 4,448ft^2 (413m^2) of total heat exchange surface
- **Other** - electrical transmission losses, lights, return water piping losses, building envelope, rack radiant, back of rack air exfiltration, VRF AHU fans



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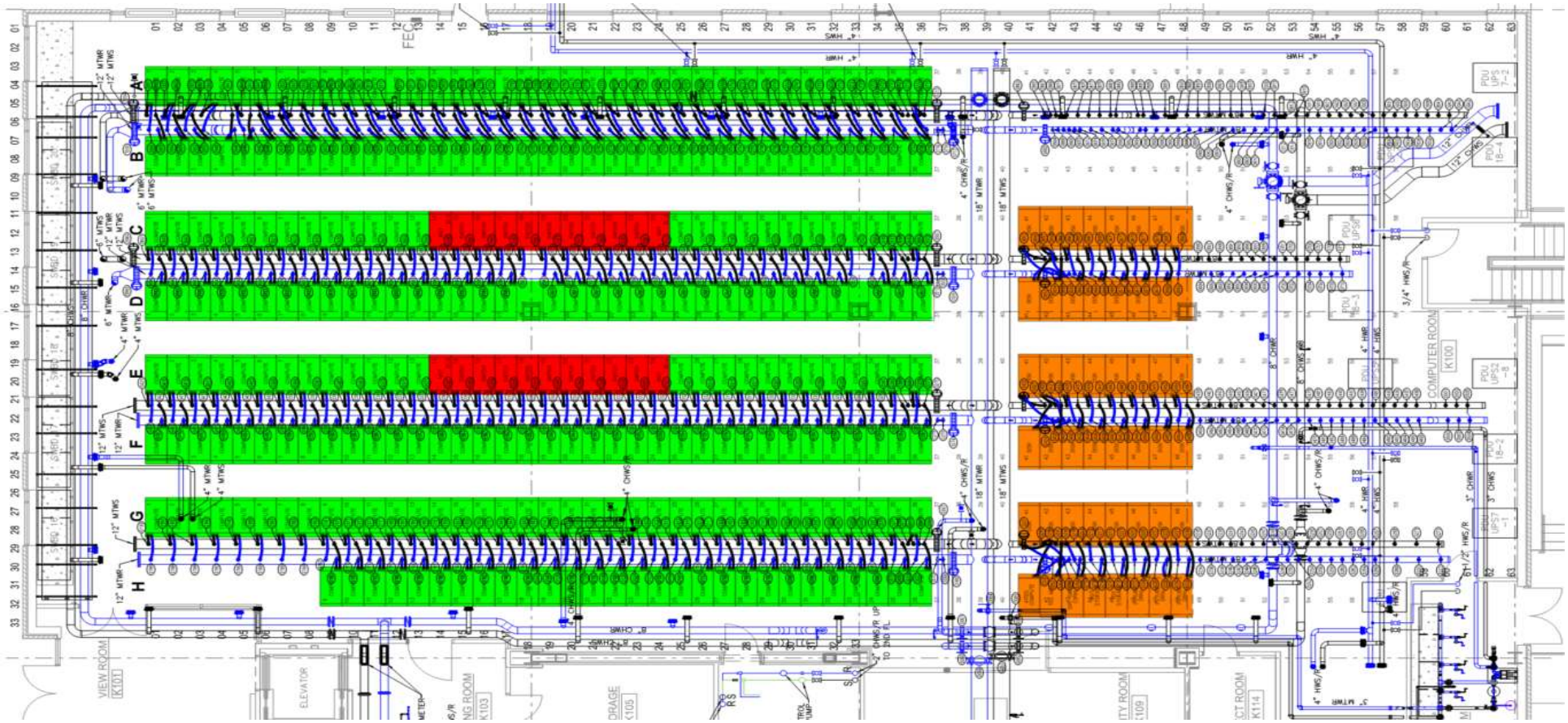
System Description – What does the cooling system see in the data center?



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System Components – Facility Improvements

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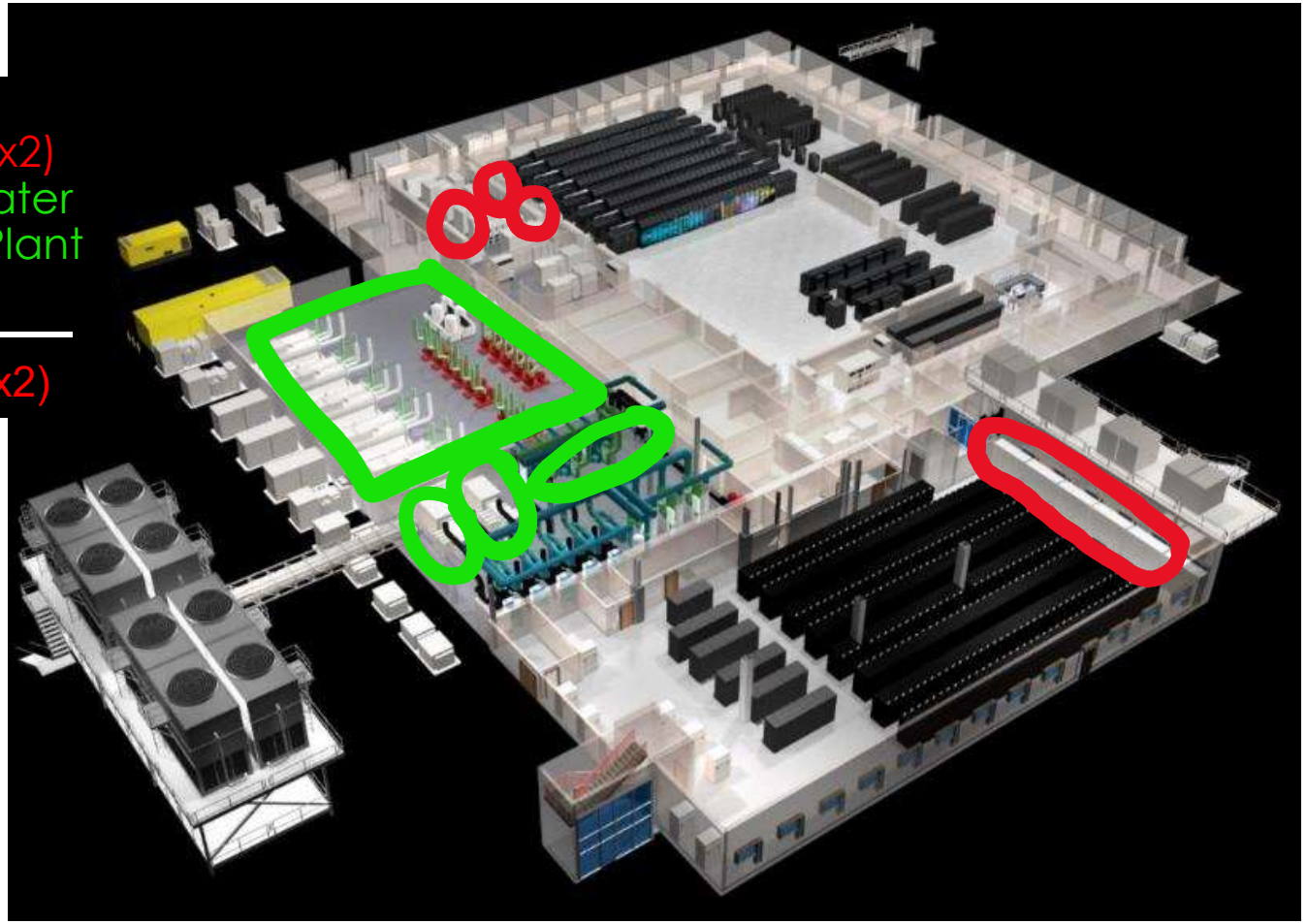
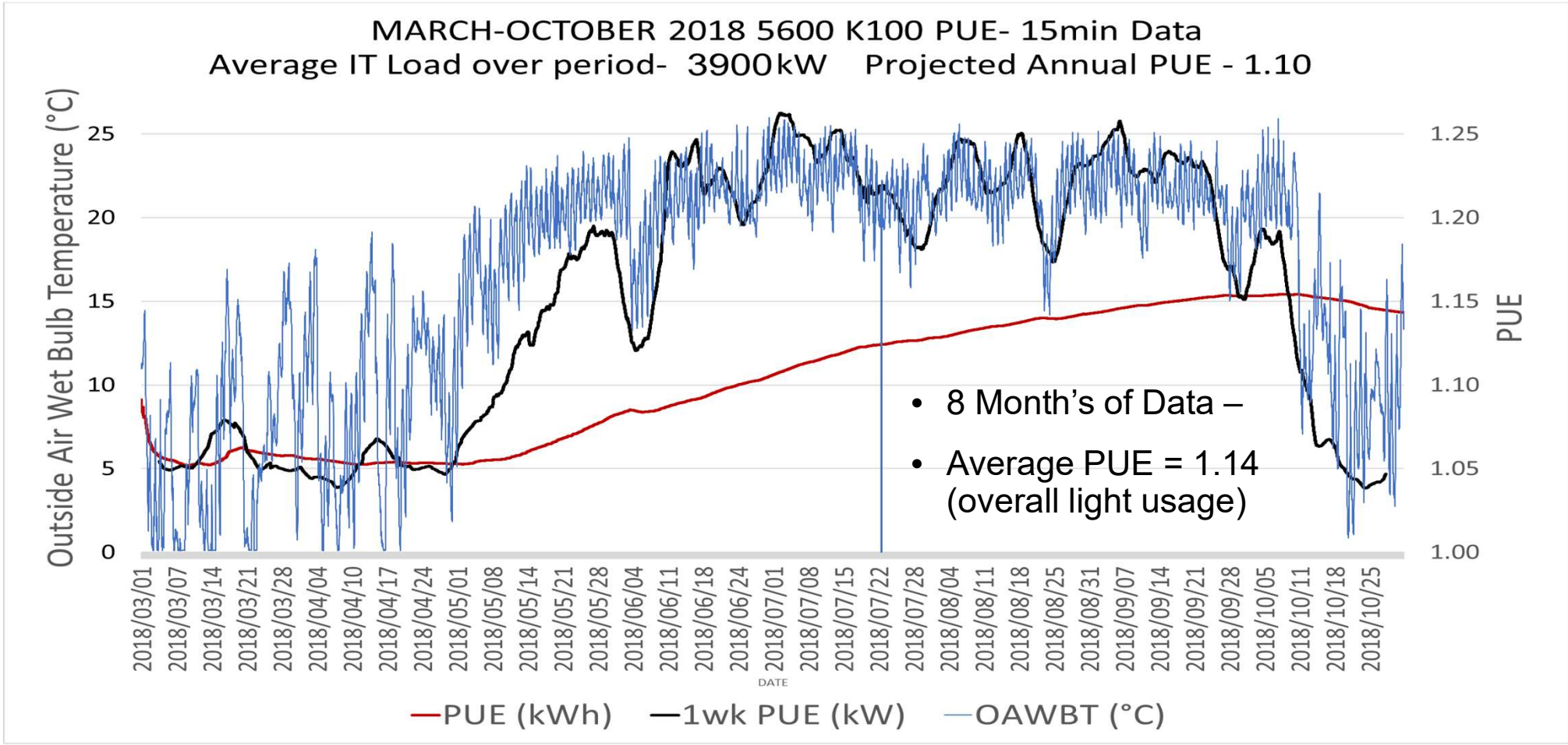
PUE – ORNL's Measurement Overview

$$PUE = \frac{\text{MSBs(x5)} + \text{ATS} + \text{UPSs(x2)} + \text{MSBs(x2)} + \text{Chilled Water Cooling Load} \times \text{Chiller Plant Efficiency}}{\text{MSBs(x5)+ATS+UPSs(x2)}}$$



Cooling System Performance - PUE



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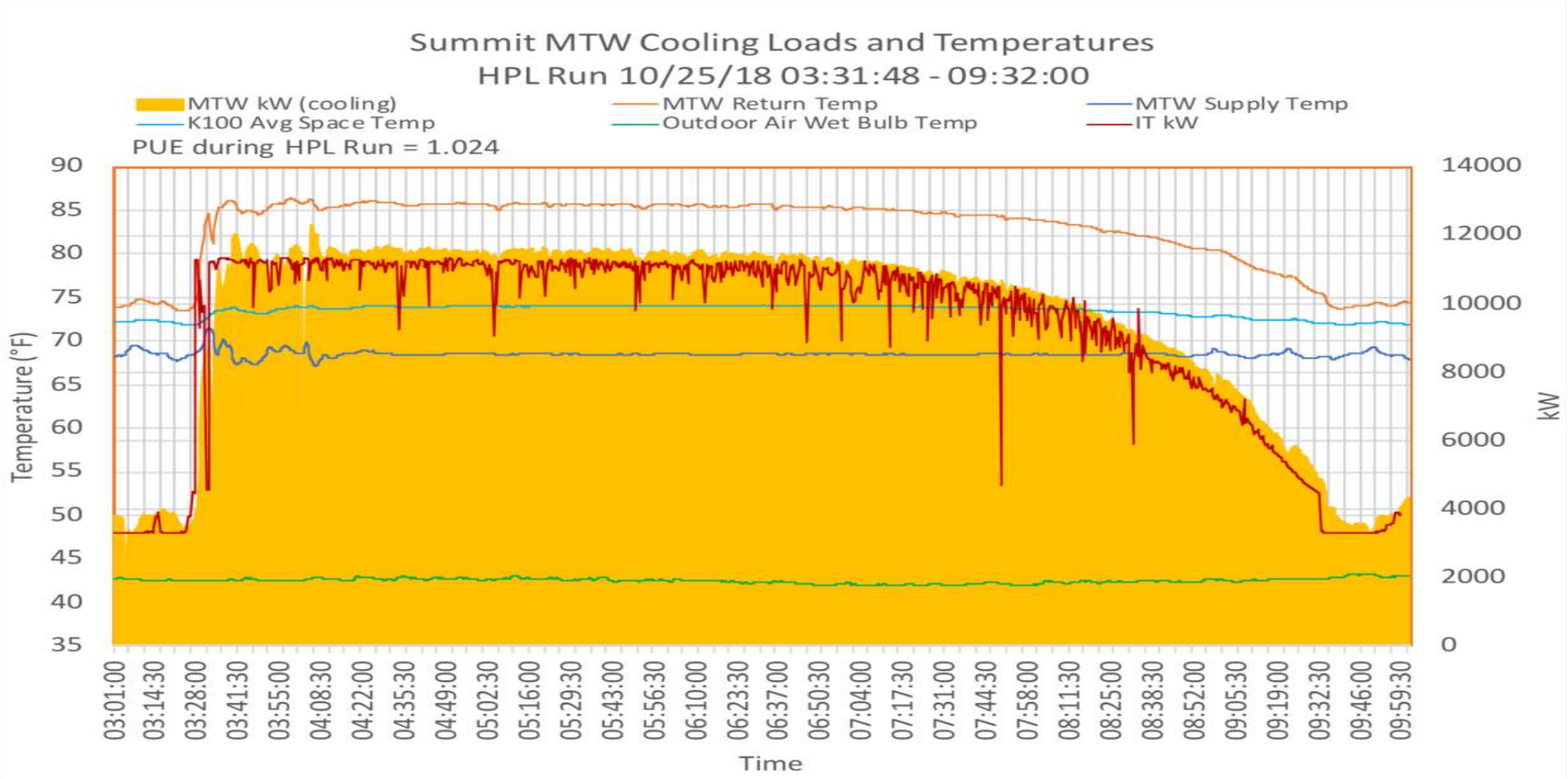
Cooling System Performance – HPL Runs



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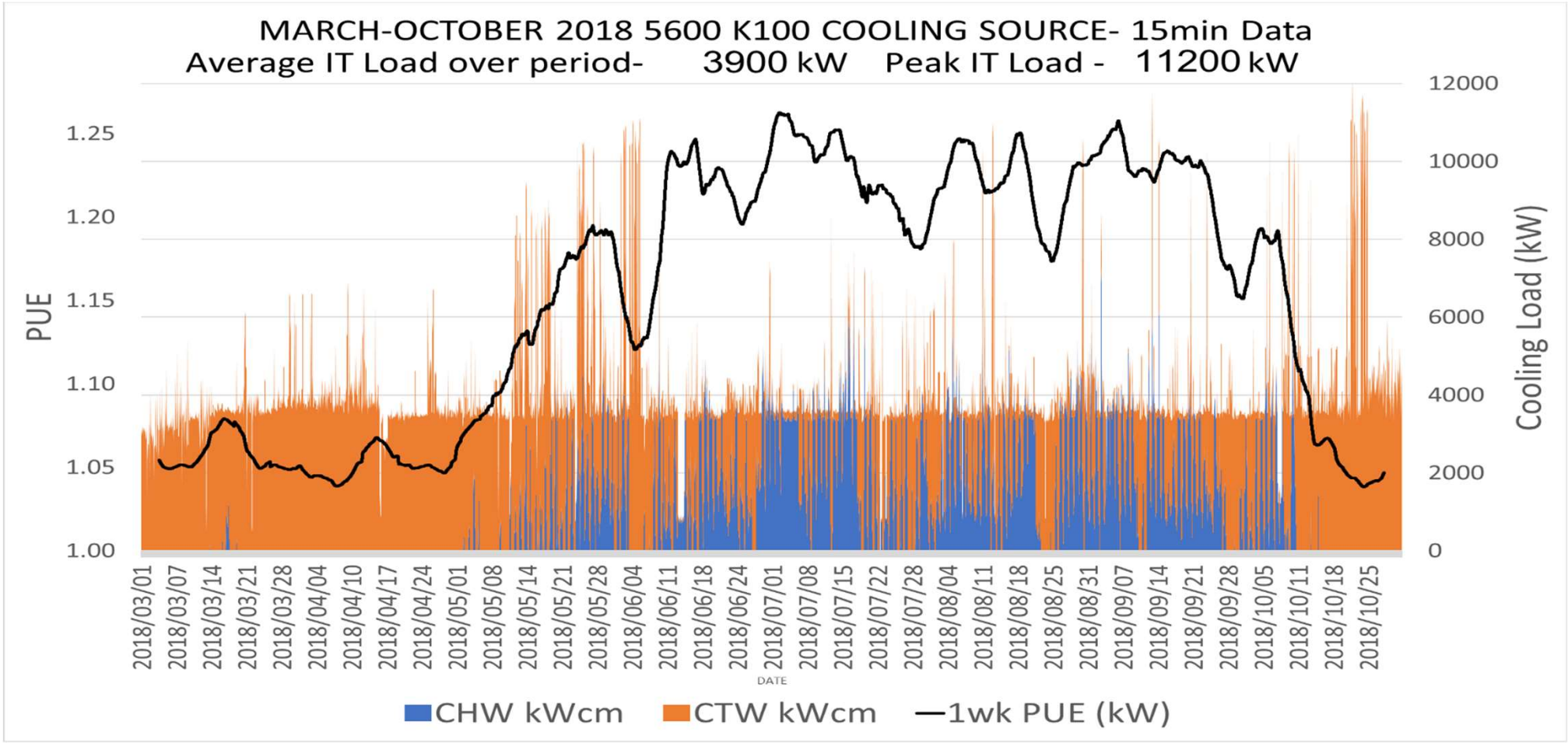
Cooling System Performance – Cooling Source



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Cooling System Performance – Chilled Water Use

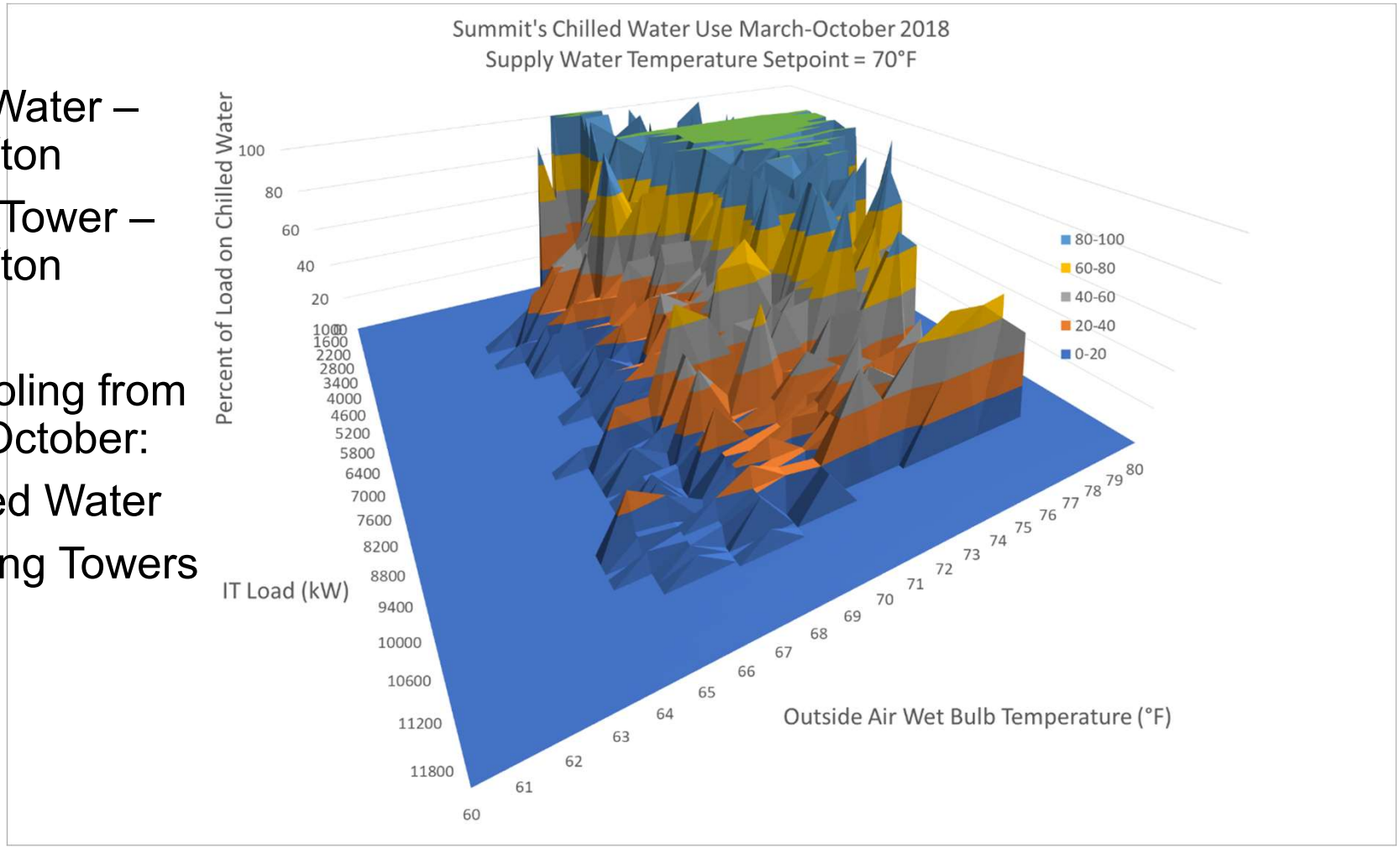
Efficiencies

- Chilled Water – ~0.8kW/ton
- Cooling Tower – ~0.2kW/ton

kWh of cooling from March to October:

22% Chilled Water

78% Cooling Towers



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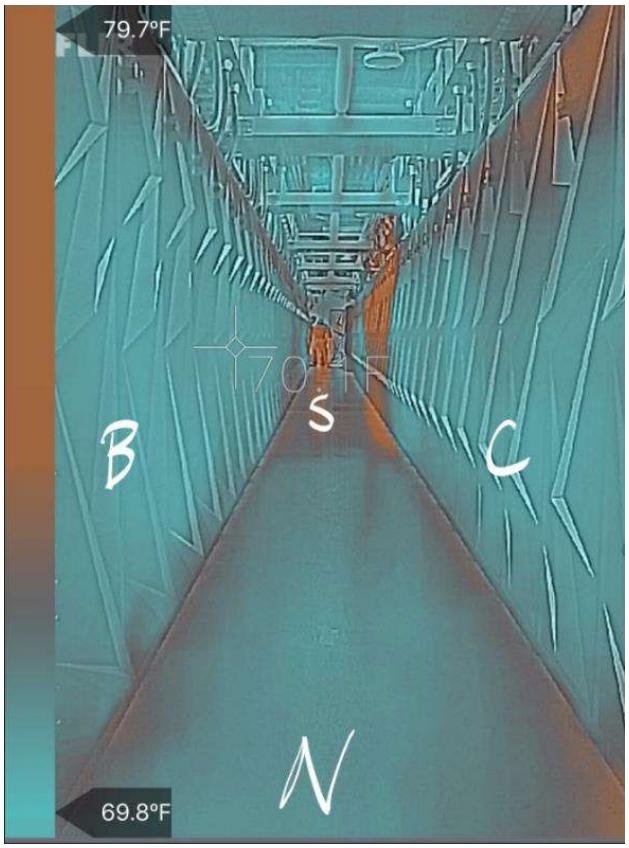
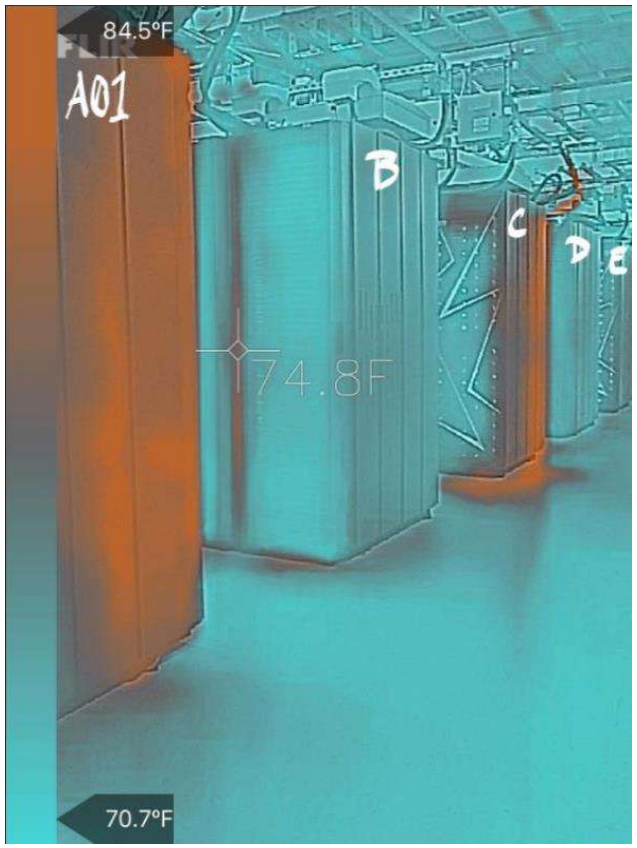
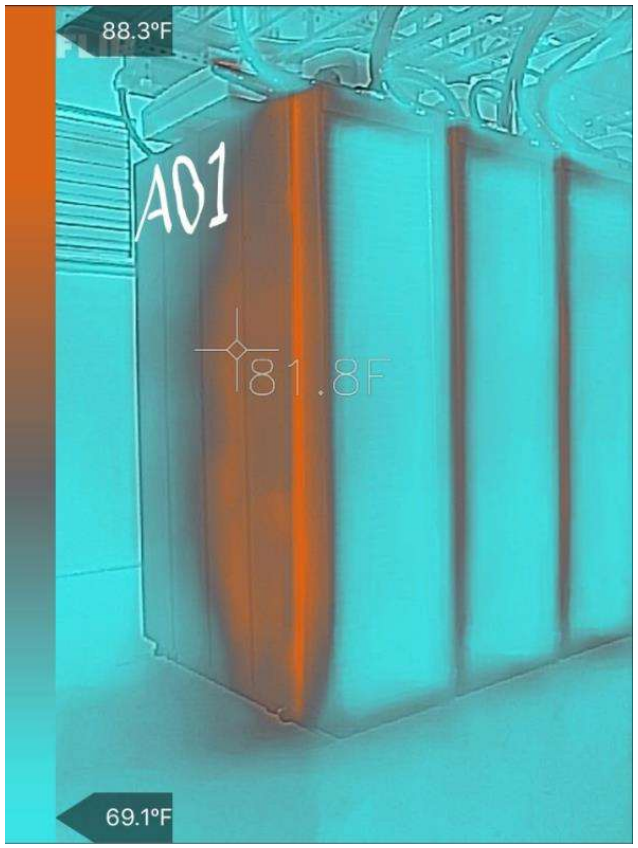
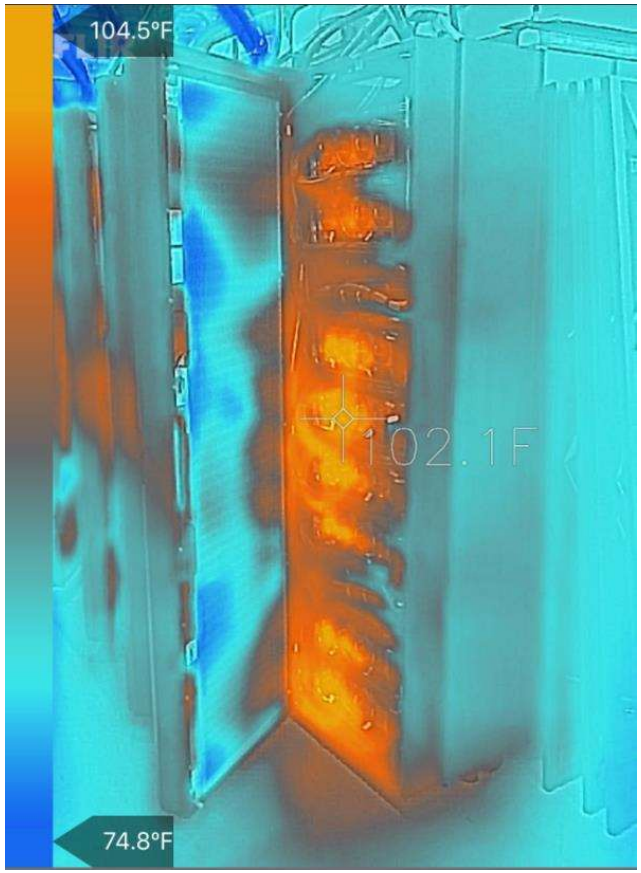
Cooling System Performance – Within the Data Center

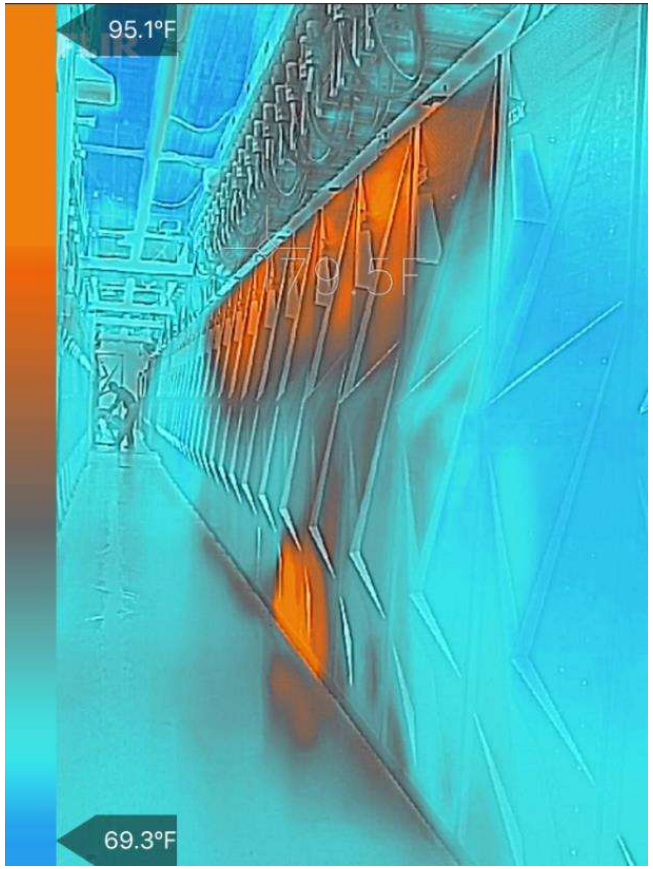


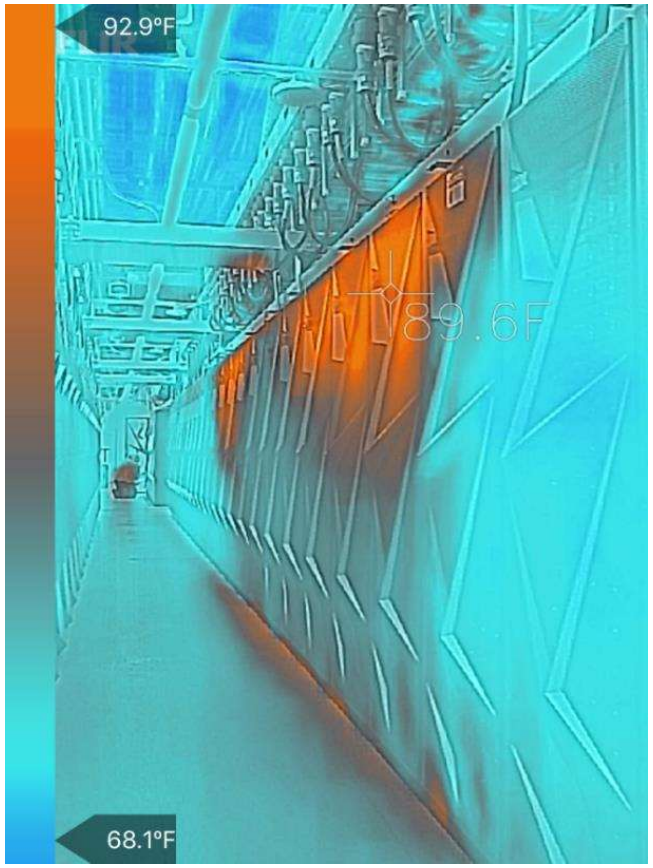




Cooling System Performance – Within the Data Center







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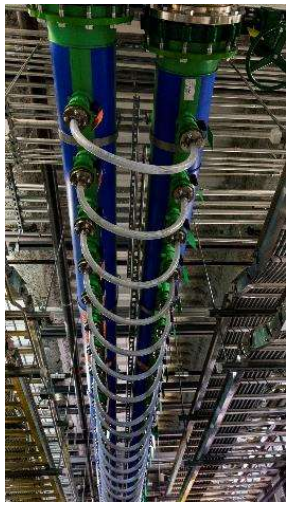
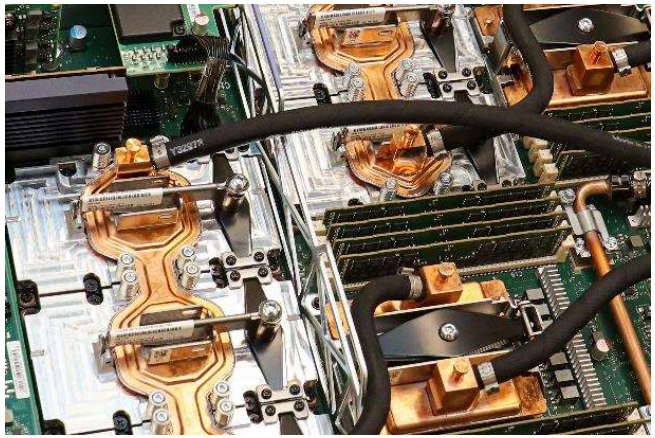
Thank You





https://www.olcf.ornl.gov/summit/